Statistical Thermodynamics in Chemistry and Biology

Introduction

Per-Olof Åstrand

D3-119 Realfagsbygget, Department of Chemistry,
Norwegian University of Science and Technology,
per-olof.aastrand@ntnu.no

January 5, 2018

Course in statistical thermodynamics and thermodynamics

- Lecturers: Per-Olof Åstrand (coordinator): per-olof.aastrand@ntnu.no
  Raffaela Cabriolu: raffaela.cabriolu@ntnu.no
- Lectures Mon, 15-17, R3; Fri, 14-16, R3
- Exercises: Raffaela Cabriolu (coordinator), Christopher Fjeldstad
  Mon, 17-19, R10; Thu, 16-18, R3
  The first exercise session: Mon 15.01
- Lectures will this year be in English. Teaching assistants speak Norwegian and English.
- Last date for teaching activities: Mon 23.04

Literature

- Book: Ken A. Dill and Sarina Bromberg,
  Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience, 2nd ed., Garland Science, 2010.
- Some exercises are taken from the book.
  Solutions will not be handed out. A list of answers is provided.
- A second set of exercises (including previous exams) are available with solutions.
- A basic goal is to learn how to solve exercises.

Exam

- Exam date: 16.05, 15.00-19.00 in KJL1
- Written exam (code **A**: it is allowed to bring books and notes)
- Learn to use the book and own notes!

Learning outcome

- *The course introduces the basis of statistical thermodynamics with examples from chemistry and biology*
- Introductory course
- General course - knowledge applicable in “all” fields
- Fundamental course - generic phenomena
- Theoretical course
- Pilot project: Python-based exercises (obligatory from 2017).
  6 exercises in total

Learning outcome

From the study handbook

After the course, the student is expected to be able to:

- Explain the basic concepts and principles in statistical thermodynamics.
- Use lattice models to study basic phenomena in chemistry and nanoscience.
- Construct new models based on the basic principles in statistical thermodynamics.

Learning methods

- One overview lecture on most chapters
- Some chapters (mathematics) are given only as exercises
- Around 3-5 suggested exercises per chapter
- Focus this year: to get the Python exercises integrated in the course

Communication

- Reference group - three persons
- Blackboard for information/messages from teachers
- Ask questions! Both on new and old topics.
- Ok to ask the teaching assistants on ”old” exercises.

Some advice

- Everything is connected in the course. We use all the previous material all the time.
- Thus:
  - Work continuously: not everything is easy to understand from the start, but it is the same concepts coming over and over again.
  - Do not lag behind. Drop some of the recommended exercises on the previous chapter, and return to them later.
  - Work together in small groups. Both discussing and explaining the text to each other, and solving the exercises.

Contents

- What is statistical thermodynamics (statistical mechanics)?
  - Connection between microscopic and macroscopic theory
- What is thermodynamics?
  - Macroscopic theory
- Nanoscience is at the mesoscopic level. What does that mean?

Questions to you

- What is temperature?
- What is entropy?
- What is the chemical potential?
- What is the hydrophobic effect?
- Why is water an unusual liquid?